CHAPTER 3

RADAR SAFETY

LEARNING OBJECTIVES

Upon completing this chapter, you should be able to do the following:

1. Identify radiation and other types of hazards possibly encountered when maintaining and operating radars.

2. Identify safety precautions when encountering radiation hazards.

INTRODUCTION

As a Fire Controlman, and a possible work-center supervisor, you not only need to understand radar systems and their components and associated equipments, but you also need to understand the basic safety requirements associated with operating radar systems.

This chapter discusses in detail the radiation hazards applicable to radar maintenance and operation. Refer to *Fire Controlman,* Volume 1, *Administration and Safety,* for discussions on additional safety items that also apply to radar, such as measuring voltage on energized equipment, using protective equipment, following proper tag-out procedures, and identifying radio-frequency (RF) hazards.

RADIATION HAZARDS

Much of your radar gear (if labeled correctly) will have radiation hazard (RADHAZ) warnings attached. These labels indicate a radiation hazard that may produce RF electromagnetic fields intense enough to actuate electro-explosive devices, cause spark ignition of volatile combustibles, or produce harmful biological effects in humans.

You will probably not be able to eliminate all the hazards caused by normal operation of your radar equipment. Therefore, you will need to minimize them during certain evolutions. The most effective way to reduce radiation hazards is to shut down equipment when possible or to locate equipment so that radar main beams do not illuminate ordnance, personnel, or fuels.

Electromagnetic Radiation Hazards (Hazards to Ordnance), NAVSEA OP 3565, requires each commanding officer to establish procedures for maintaining positive control of RF transmitting equipment and to coordinate the actions of personnel working near emitters or handling ordnance. By instruction, no one may turn on any transmitting equipment without proper authorization from the supervisor in charge of operations. That means that you need permission to operate, test, rotate, or radiate electronic gear.

Each command has an emissions control (EMCON) bill that establishes the level of EMCON required during certain types of operations. The EMCON bill identifies the equipment to be secured while each EMCON level is set. Label your radar equipment according to your EMCON bill to make identification easy and to provide for timely shutdown.

This section briefly discusses the primary adverse affects of electromagnetic radiation on material and personnel and the programs designed to minimize those effects.

HAZARDS OF ELECTROMAGNETIC RADIATION TO ORDNANCE

During on-loading or off-loading of ammunition, there is a danger that RF electromagnetic fields could accidentally activate electro-explosive devices (EEDs) or electrically initiated ordnance. This is a very real hazard to the ordnance, the ship, and the crew. The Hazards of Electromagnetic Radiation to Ordnance (HERO) Program was developed to control these types of situations.

When HERO is set, it usually requires that radars be secured. When you are in port and must conduct any radar maintenance requiring rotating the antenna or radiating, always coordinate your actions with your base operations department via the command duty officer (CDO).

HERO conditions anywhere in the area could be affected by your radar. Even if you just want to radiate a short period for an operational test, check with the officer of the day (OOD) or the CDO first.

Table 3-1 (an example of tables found in NAVSEA OP 3565, volume II, part 1) identifies ordnance hazards associated with common electronic equipment.

Table 3-1.—Exposure to Main Beam Radiation of Shipboard and Shore Station Equipment

Transmitter	Fixed Beam Hazard			Moving Beam		
	Distance		Maximum Exposure Time	Personnel Hazard	Distance	
	Meters	Feet			Meters	Feet
AN/SPS-37A	14	45	0	No	---	---
AN/SPS-38	15	50	0	No	---	---
AN/SPS-39,A	120	400	1	No	---	---
AN/SPS-40,A,B	18	60	1	No	---	---
AN/SPS-41	No Hazard	No Hazard	6	No	---	---
AN/SPS-42	55	180	1	No	---	---
AN/SPS-43	21	70	0	No	---	---
AN/SPS-43A	14	45	0	No	---	---
AN/SPS-45	14	45	0	No	---	---
AN/SPS-46	No Hazard	No Hazard	6	No	---	---
AN/SPS-48	250	840	0	No	---	---
AN/SPS-49	61	200	1	No	---	---
AN/SPS-51	No Hazard	No Hazard	6	No	---	---
AN/SPS-52	130	440	0	No	---	---
AN/SPS-53,A,E	No Hazard	No Hazard	6	No	---	---
AN/SPS-55	8	25	0	No	---	---
AN/SPS-57	No Hazard	No Hazard	6	No	---	---
AN/SPS-58	No Hazard	No Hazard	6	No	---	---
AN/SPS-58A	2	8	4	No	---	---
AN/SPS-58C	2	5	4	No	---	---
AN/SPS-63	No Hazard	No Hazard	6	No	---	---
AN/SPS-65	8	25	4	No	---	---
AN/SPS-67	11	35	1	No	---	---
AN/SPW-2A,B	No Hazard	No Hazard	6	N/A	---	---
AN/SSC-6	240	800	0	N/A	---	---
AN/TPN-8	14	45	2	N/A	---	---
AN/TPQ-10	No Hazard	No Hazard	6	N/A	---	---
AN/TPQ-27	No Hazard	No Hazard	6	N/A	---	---
AN/TPS-1D,G	9	30	2	No	---	---
AN/TPS-22	2	6	1	No	---	---

HAZARDS OF ELECTROMAGNETIC RADIATION TO FUELS

The Hazards of Electromagnetic Radiation to Fuels (HERF) Program was developed to protect fueling operations. During fueling operations, RF electromagnetic fields with a very large intensity could produce a spark that could ignite the volatile combustibles. Therefore, certain radars may need to be shut down during fueling operations. Check your HERF publications for specific details.

HAZARDS OF ELECTROMAGNETIC RADIATION TO PERSONNEL

The Hazards of Electromagnetic Radiation to Personnel (HERP) Program was developed to protect personnel from RF electromagnetic radiation. Wherever a radar or a transmitter is operating, there is a danger that the RF electromagnetic fields may produce harmful biological effects in humans exposed to them. The following subsections identify the typical hazards and the steps you can take to minimize those hazards.

Radio-Frequency Hazards

Radio-frequency (RF) hazards to personnel are caused by overexposure to RF energy. As a Fire Controlman, you should refer to NAVSEA OP 3565, volume I, to understand the biological hazard levels for exposure to RF radiation, as established by the Bureau of Medicine and Surgery.

SAFE LIMITS.— Safe limits are based on the power density of the radiation beam and the exposure time of the human body. Table 3-2 (an example of tables in NAVSEA OP 3565, volume I) identifies the safe limits associated with common electronics equipment.

Table 3-2.—Safe Separation Distances for Radar, Electronic Warfare, and Navigational Aids Equipment

System	Gain (dBi)	HERO Susceptible (Meters/Feet)	HERO Unsafe/ HERO Unreliable (Meters/Feet)
AN/SLQ-26(V)6, (V)7, (V)8, (V)10	19	62/203	88/289
AN/SLQ-29	16	3/10	3/10
AN/SLQ-30	19	3/10	3/10
AN/SLQ-32(V)3	10	4/13	9/30
AN/SPG-34	36	12/39	16/52
AN/SPG-49B Acquisition	34	249/817	351/1152
AN/SPG-49B CWI	0	5/16	7/23
AN/SPG-49B Track	34	236/774	333/1093
AN/SPG-50	36	15/49	21/69
AN/SPG-51	35.5	131/430	185/607
	36.5	147/482	207/679
AN/SPG-51 CWI (Narrowbeam)	2	3/10	3/10
AN/SPG-51 CWI (Widebeam)	16	4/13	6/20
AN/SPG-51 Track	35.5	131/430	185/607
AN/SPG-51B CWI	16	7/23	9/30
	44	437/1434	617/2024
AN/SPG-51C	39.5	190/623	268/879
AN/SPG-51C CWI (Narrowbeam)	45	491/1611	692/2270
ANSPG-51C CWI (Widebeam)	12.5	6/20	8/26
AN/SPG-51D	39.5	514/1686	725/2379
AN/SPG-51D (Narrowbeam)	45	491/1611	692/2270
AN/SPG-51D (Widebeam)	12.5	6/20	8/26
AN/SPG-51D Tracking	39.5	240/787	338/1109
AN/SPG-53A	36	25/81	35/114
AN/SPG-53F	36	25/81	35/114
AN/SPG-55A CWI Mode 2250	8	5/16	7/23
AN/SPG-55A CWI Mode 2750	47	457/1499	644/2113
AN/SPG-55A LR Acquisition, MSL Mode (Track Beam-Long), Track Mode (Long and Short)	39	98/322	138/453
AN/SPG-55A LR (Short Track), MSL Mode (Guidance Beam), MSL Mode (Track Beam - Short)	39	54/177	76/249
AN/SPG-55A MSL Mode (Capture Beam), Short Range (Short Track)	29	17/56	24/79
AN/SPG-55A Short Range (Long Track)	29	31/102	44/144

RF BURNS.— Voltages of enough potential to cause a burn injury can be induced on metallic items from nearby transmitting antennas. However, there must be actual physical contact for the burn to occur. You can help prevent contact by ensuring that warning signs are placed properly and are obeyed.

Safety Precautions

During normal operations, personnel can easily avoid most hazards if the hazards are labeled properly. However, during maintenance, some hazards must be eliminated by specific, planned actions, such as tag-outs, man-aloft chits, and equipment safety devices. Using all safety precautions is the personal responsibility of the technician.

TAG-OUTS.— Hanging a proper tag can save your life. Using tags improperly or not at all will eventually put you, maybe your best buddy, maybe your whole crew, in a Navy mishap report. Ensure that required tags are installed properly and observed

fully. Tag-out procedures are covered in *Fire Controlman,* Volume 1, *Administration and Safety,* NAVEDTRA 12405.

MAN-ALOFT CHITS.— Man-aloft chits protect you from RF hazards when you are working on radar antennas. If the chit is run properly, the operations on your ship and any ship next to you are modified to keep you safe. Heed the requirements and follow the procedures.

EQUIPMENT SAFETY DEVICES.— Devices built into equipment, such as cut-off switches on antennas, are for your safety. A cut-off switch, when set, will keep you out of danger. It will prevent someone from rotating the antenna from a remote location. But, you, the technician, must set the cut-off switch for it to be of any use. Equipment safety devices are there for your protection. Use them!

Everywhere you go in the Navy, there will be communications and radar equipment that produce electromagnetic radiation environments (EMEs). And, there will always be electromagnetic radiation hazards introduced by operating those equipments.

To be safe, you should become familiar with the hazards associated with your equipment. If you install new equipment, update your emission control (EMCON) bill. Refer to NAVSEA OP 3565, volume I or II, to determine the hazards associated with specific equipments.

OTHER RADAR HAZARDS

You cannot always avoid hazards when working on radars. In these instances, take what precautions you can and, at least, be prepared for an emergency. There are various safety concerns associated with working on energized equipment, going aloft, or handling CRTs. Refer to NAVEDTRA 12405 for more detailed information on other radar hazards.

Never think about electronics without thinking about safety. Learn from the safety information you get from the *Ship's Safety Bulletins,* Navy mishap reports, and personal experience. Follow established procedures and all safety instructions. Live longer.

ENERGIZED EQUIPMENT

You may have to work on energized equipment on a hectic bridge, in a crowded combat information center (CIC), or in a cramped radar equipment room. These are not ideal safety environments. As these spaces are maintained by various people, always check the rubber matting around your equipment. Also check other protective equipment before using them, such as rubber gloves and shorting probes.

WARNING!

NEVER WORK ALONE ON ENERGIZED EQUIPMENT.

On ships with minimum manning, you may not have the option of using another Fire Controlman as a safety observer. Make sure that whoever is going to observe you is qualified in cardiopulmonary resuscitation (CPR). Brief your observer on what you will be doing. Physically show him where the cut-off switch is located. Have him standby at a safe distance with a rope or a wooden cane to pull you from the equipment, if necessary.

MAN-ALOFT CHITS

When you work aloft on radar antennas, your man-aloft chit protects you from the RF radiation hazards. But, you also need to be protected from falling.

Perform the maintenance required by the Planned Maintenance System (PMS) for safety harnesses every time you use a harness. And remember, even a good harness can’t save you unless you use it correctly. When you go up the mast, attach your harness properly so you can’t free-fall to the deck. Attach a line to any tools you carry up, so they are unable to

free-fall. Set the cut-off switches for any antennas along the way.

WARNING!

NEVER WORK ALOFT WITHOUT A SAFETY OBSERVER.

Safety observers are responsible for the safety of those walking underneath you as well as for your safety. They should position themselves so you can communicate with them without having to come down. The safety observer will pass your information to everyone else. If something is falling, communicate quickly.

It is your life; so be sure you pick good safety observers who are aware of what type of maintenance you are going to do. They also need to know whom to contact if you run into technical problems.

CATHODE-RAY TUBES

Cathode-ray tubes (CRTs) are part of radar scopes. You will definitely have to work around them. You will probably, at one time or another, pack or unpack, install, repair, or dispose of a CRT. There are some very real dangers associated with handling a CRT. Always take the precautions discussed in NAVEDTRA 12405 whenever you handle a CRT.

RECOMMENDED READING LIST

NOTE: Although the following references were current when this TRAMAN was published, their continued currency cannot be assured. Therefore, you need to ensure that you are studying the latest revision.

Electromagnetic Radiation Hazards (Hazards to Ordnance), NAVSEA OP 3565, Volume II, Naval Sea Systems Command, Washington, DC, April 1995.

Electromagnetic Radiation Hazards (Hazards to Personnel, Fuel, and Other Flammable Material, NAVSEA OP 3565, Volume I, Naval Sea Systems Command, Washington, DC, 1979.

APPENDIX I

GLOSSARY

This glossary defines abbreviations and acronyms as they are used in this training manual.

ac— alternating current

AFC— automatic frequency control

AGC— automatic gain control

AM— amplitude modulation/modulated

BWO— backward-wave oscillator

CAP— combat air patrol

CDO— command duty officer

CFA— crossed-field amplifier

CFAR— constant false-alarm rate

CIC— combat information center

COHO— coherent oscillator

COSRO— conical scan on receive only

CPR— cardiopulmonary resuscitation

CRT— cathode-ray tube

CW— continuous wave

dB— decibel

de— direct current

EA— electronic attack

EMCON— emissions control

EP— electronic protection

FM— frequency modulation/modulated

GHz— gigahertz

HERF— Hazards of Electromagnetic Radiation to Fuel

HERO— Hazards of Electromagnetic Radiation to Ordnance

HERP— Hazards of Electromagnetic Radiation to Personnel

IF— intermediate frequency

kyd— 1,000 yards

LC— inductance-capacitance

LNA— low-noise amplifier

LO— local oscillator

MHz— megahertz

MTI— moving-target information/indicator

OOD— officer of the day

PMS— Planned Maintenance System

PPI— plan position indicator

PRF— pulse-repetition frequency

PRR— pulse-repetition rate

PRT— pulse-repetition time

RADHAZ— radiation hazard

RC— resistance/capacitance

RF— radio frequency

SCR— silicon-controlled rectifier

STALO— stable local oscillator

STAMO— stabilized master oscillator

STC— sensitivity time control

TWT— traveling-wave tube

APPENDIX II

REFERENCES USED TO DEVELOP THIS TRAMAN

Electromagnetic Radiation Hazards (Hazards to Ordnance), NAVSEA OP 3565, Volume II, Naval Sea Systems Command, Washington, DC, April 1995.

Electromagnetic Radiation Hazards (Hazards to Personnel, Fuel, and Other Flammable Material), NAVSEA OP 3565, Volume I, Naval Sea Systems Command, Washington, DC, 1979.

Microwave Principles, Module 11, Navy Electricity and Electronics Training Series, NAVEDTRA 172-11-00-87, Navy Education and Training Program Management Support Activity, Pensacola, FL, 1987.

Radar, NAVSEA SE000-00-EIM-020, *Electronics Installation and Maintenance Book* (EIMB), Naval Sea Systems Command, Washington, DC, 1974.

Radar Principles, Module 18, Navy Electricity and Electronics Training Series, NAVEDTRA 172-18-00-84, Navy Education and Training Program Development Center, Pensacola, FL, 1984.*

* Effective 1 September 1986, the Naval Education and Training Program Development Center became the Naval Education and Training Program Management Support Activity.

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FIRE CONTROLMAN, VOLUME 2, *FIRE-CONTROL RADAR FUNDAMENTALS* NAVEDTRA 12404

Prepared by the Naval Education and Training Professional Development and Technology Center (NETPDTC), Pensacola, Florida

Congratulations! By enrolling in this course, you have demonstrated a desire to improve yourself and the Navy Remember, however, this self-study course is only one part of the total Navy training program. Practical experience. schools, selected reading, and your desire to succeed are also necessary to successfully round out a fully meaningful training program. You have taken an important step in self-improvement. Keep up the good work.

HOW TO COMPLETE THIS COURSE SUCCESSFULLY

ERRATA: If an errata comes with this course, make all indicated changes or corrections before you start any assignment. Do not change or correct the associated text or assignments in any other way.

ASSIGNMENTS: The text pages that you are to study are listed at the beginning of each assignment. Study these pages carefully before attempting to answer the questions in the course. Pay close attention to tables and i Illustrations because they contain information that will help you understand the text. Read the learning objectives provided at the beginning of each chapter or topic in the text and/or preceding each set of questions in the course. Learning objectives state what you should be able to do after studying the material. Answering the questions correctly helps you accomplish the objectives.

SELECTING YOUR ANSWERS: After studying the associated text, you should be ready to answer the questions in the assignment. Read each question carefully, then select the BEST answer. Be sure to select your answer from the subject matter in the text. You may refer freely to the text and seek advice and information from others on problems that may arise in the course. However, the answers must be the result of your own work and decisions. You are prohibited from referring to or copying the answers of others and from giving answers to anyone else taking the same course. Failure to follow these rules can result in suspension from the course and disciplinary action.

ANSWER SHEETS: You must use answer sheets designed for this course (NETPMSA Form 1430/5, Stock Ordering Number 0502-LP-216-0100). Use the answer sheets provided by your Educational Services Officer (ESO), or you may reproduce the one in the back of this course booklet.

SUBMITTING COMPLETED ANSWER SHEETS: As a minimum, you should complete at least one assignment per month. Failure to meet this requirement could result in disenrollment from the course. As you complete each assignment, submit the completed answer sheet to your ESO for grading. You may submit more than one answer sheet at a time.

GRADING: Your ESO will grade each answer sheet and notify you of any incorrect answers. The passing score for each assignment is 3.2. If you receive less than 3.2 on any assignment, your ESO will list the questions you answered incorrectly and give you an answer sheet marked "RESUBMIT." You must redo the assignment and complete the RESUBMIT answer sheet. The maximum score you can receive for a resubmitted assignment is 3.2.

COURSE COMPLETION: After you have submitted all the answer sheets and have earned at least 3.2 on each assignment, your command should give you credit for this course by making the appropriate entry in your service record.

NAVAL RESERVE RETIREMENT CREDIT: If you are a member of the Naval Reserve, you will receive retirement points if you are authorized to receive them under current directives governing retirement of Naval Reserve personnel. For Naval Reserve retirement, this course is evaluated at 2 points. (Refer to BUPERSINST 1001.39 for more information about retirement points.)

STUDENT QUESTIONS: If you have questions concerning the administration of this course, consult your ESO. If

you have questions on course content, you may contact NETPDTC at:

DSN: 922-1548
Commercial: (904) 452-1548
FAX: 922-1819
INTERNET: N311.products@smtp.cnet.navy.mil

COURSE OBJECTIVES: In completing this nonresident training course, you will demonstrate a knowledge of the subject matter by correctly answering questions on the following subjects:

- basic radar concepts,
- equipment requirements for basic radar systems,
- types of energy transmission employed by radar systems,
- scanning techniques used in radar systems,
- major components in today's radar transmitters,
- design requirements of an effective radar receiver,
- radiation and other types of hazards in maintaining and operating radars, and
- safety precautions when encountering radiation hazards.

INSTRUCTIONS ON ANSWERING QUESTIONS

Naval courses may include several types of questions--multiple-choice, true-false, matching, etc. The questions are not grouped by type but by subject matter. They are presented in the same general sequence as the textbook material upon which they are based. This presentation is designed to preserve continuity of thought, permitting step-by-step development of ideas. Not all courses use all of the types of questions available. You can readily identify the type of each question, and the action required, by reviewing of the samples given below.

MULTIPLE-CHOICE QUESTIONS

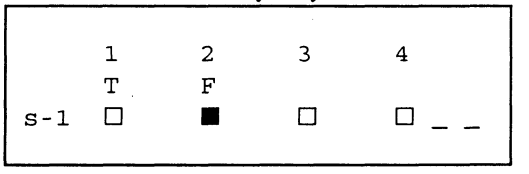
Each question contains several alternative answers, one of which is the best answer to the question. Select the best alternative, and blacken the appropriate box on the answer sheet.

SAMPLE

s-1 The first U.S. Navy nuclear-powered vessel was what type of ship?

1. Carrier
2. Submarine
3. Destroyer
4. Cruiser

Indicate in this way on your answer sheet:



TRUE-FALSE QUESTIONS

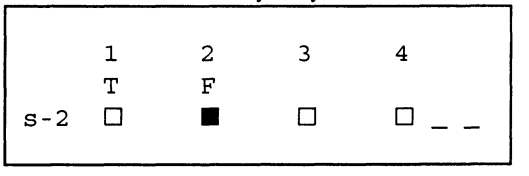
Mark each statement true or false as indicated below. If any part of the statement is false, the entire statement is false. Make your decision, and blacken the appropriate box on the answer sheet.

SAMPLE

s-2. Shock will never be serious enough to cause death.

1. True
2. False

Indicate in this way on your answer sheet:



MATCHING QUESTIONS

Each set of questions consists of two columns, each listing words, phrases or sentences. Your task is to select the item in column B which is the best match for the item in column A. Items in column B may be used once, more than once, or not at all. Specific instructions are given with each set of questions. Select the numbers identifying the answers and blacken the appropriate boxes on your answer sheet.

SAMPLE

In answering questions s-3 through s-6, SELECT from column B the department where the shipboard officer in column A functions. Responses may be used once, more than once, or not at all.

A. OFFICER	B. DEPARTMENT
s-3. Damage Control Assistant	1. Operations Department
s-4. CIC Officer	2. Engineering Department
s-5. Disbursing Officer	3. Supply Department
s-6. Communications Officer	4. Navigation Department

Indicate in this way on your answer sheet:

ASSIGNMENT 1

Textbook Assignment: "Introduction to Basic Radar Systems," chapter 1, pages 1-1 through 1-11;
"Basic Radar Systems," chapter 2, pages 2-1 through 2-30; and
"Radar Safety," chapter 3, pages 3-1 through 3-7.

1-1. Radar surface angular measurements are normally made from which direction?

1. Counter-clockwise from true north
2. Clockwise from true north
3. North/south
4. East/west

1-2. The angle measured clockwise from true north in the horizontal plane defines which of the following terms?

1. True north
2. Line-of-sight range
3. True bearing/azimuth
4. Horizontal plane

1-3. Which of the following factors does NOT affect the maximum range of a pulse-radar system?

1. Pulse-repetition frequency
2. Peak power of the transmitted pulse
3. Diameter of the radar dish
4. Carrier frequency

1-4. The angle between the centerline of the ship and a line pointed directly at a target is called

1. relative bearing
2. angular bearing
3. true bearing
4. angle north

1-5. What is the most common method used to transmit radar energy?

1. Frequency-modulation
2. Continuous-wave
3. Doppler
4. Pulse

1-6. What method of transmitting radar energy can be modified to use the Doppler effect?

1. Agile
2. Pulse
3. Continuous-wave
4. Frequency-modulation

1-7. *Azimuth* is a word that can be substituted for

1. pulse
2. range
3. bearing
4. frequency

1-8. According to the block diagram figure 1-4, what is considered to be the heart of a fundamental radar system?

1. Antenna system
2. Transmitter
3. Modulator
4. Duplexer

1-9. High power in the transmitter can be obtained by using which of the following components?

1. Modulator
2. Magnetron
3. Klystron
4. Either 2 or 3 above

1-10. Which of the following subsystems is used to convert RF echoes to a lower frequency?

1. Superheterodyne receiver
2. Antenna system
3. Transmitter
4. Duplexer

1-11. Which of the following radars is used to provide security against attacks at night?

1. 3-Dradar
2. Air-search radar
3. Fire-control radar
4. Surface-search radar

1-12. What radar provides continuous positional data?

1. 3-D radar
2. Tracking radar
3. Air-search radar
4. Fire-control radar

1-13. Fire-control radar operations include which of the following phases?

1. Designation, acquisition, and pulse
2. Acquisition, track, and pulse
3. Track, designation, and acquisition
4. Pulse, track, and acquisition

1-14. Basic radar systems use which of the following types of energy transmissions?

1. Pulse and continuous wave
2. Pulse and frequency modulation
3. Frequency modulation and continuous wave
4. Continuous wave and amplitude modulation

1-15. intermediate frequencies of 30 to 60 MHz are used with what type of radar system?

1. Frequency-modulation continuous wave
2. Basic continuous wave
3. Pulse Doppler
4. Basic pulse

1-16. Which of the following radar systems can detect both stationary and moving targets?

1. Basic pulse
2. Pulse Doppler
3. Basic continuous wave
4. Frequency-modulation continuous wave

1-17. The amount of Doppler shift is determined by which of the following factors pertaining to the target?

1. Angle
2. Height
3. Radial velocity
4. Relative angle

1-18. Pulse-Doppler search radars primarily use which of the following methods to detect moving targets?

1. Moving-target indication
2. Continuous wave
3. Doppler shift
4. Basic pulse

1-19. Most continuous-wave radars use a separate antenna to receive.

1. True
2. False

1-20. The limitation of determining target range with CW radars can be overcome by using which of the following methods?

1. Frequency modulation
2. Doppler shift
3. Angle shift
4. Pulse shift

1-21. What two basic scanning methods are used with today's radars?

1. Mechanical and electronic
2. Electronic and amplitude
3. Frequency and mechanical
4. Microwave and amplitude

1-22. All of the following types of scanning are included in mechanical scanning except which one?

1. Nutating waveguide
2. Angle tracking
3. Nutation
4. Fixed

1-23. What type of reference generator establishes the position of the feed horn during angle tracking?

1. Four phase
2. Three phase
3. Two phase
4. One phase

1-24. Which of the following electronic scanning methods is also referred to as simultaneous lobing?

1. Angle tracking
2. Monopulse
3. Nutating
4. COSRO

1-25. COSRO scanning is used more effectively with which of the following types of radars?

1. Pulse
2. Pulse Doppler
3. Angle tracking
4. Continuous wave

1-26. Crossed-field tubes are also known as which of the following types of devices?

1. K
2. M
3. N
4. Q

1-27. The magnetron is basically a diode and has no

1. resistance
2. plate
3. grid
4. bias

1-28. Magnetron oscillators are divided into what total number of classes?

1. Five
2. Two
3. Three
4. Four

1-29. The resonant frequency of a magnetron can be varied by varying the

1. current
2. resistance
3. inductance
4. seasoning

1-30. During initial operation, a high-power magnetron arcs from the cathode to the

1. grid
2. plate
3. anode
4. bias network

1-31. In addition to the electrical input and the magnetic field, the major difference between the CFA and the magnetron is the requirement for which of the following inputs?

1. Radio frequency
2. Continuous wave
3. Linear-beam tubes
4. Nonlinear-beam tubes

1-32. What are the two most common types of linear-beam tubes used in fire-control equipment?

1. Klystron amplifier and traveling wave
2. Two-cavity amplifier and multicavity amplifier
3. Magnetic field tube and klystron amplifier
4. Traveling wave and multicavity amplifier

1-33. Which of the following elements acts as a valve in a klystron amplifier?

1. Cathode
2. Anode
3. Plate
4. Grid

1-34. The klystron amplifier consists of what three separate sections?

1. Electron gun, collector, and heated cathode
2. Electron bunches, radio frequency, and cold cathode
3. Electron gun, radio frequency, and collector
4. Electron cavity, collector, and cathode

1-35. Which of the following elements is NOT a part of an electron gun?

1. Anode
2. Cathode
3. Bias plate
4. Control grid

1-36. Multicavity klystron amplifiers can have what total number of cavities?

1. One
2. Five
3. Three
4. Seven

1-37. To overcome beam spreading on klystron amplifiers, what type of field is used?

1. Electron
2. Magnetic
3. Axial magnetic
4. Mutual repulsion

1-38. In most klystron tubes, the anode and the RF section are connected in the vacuum envelope. These connected parts are called the tube

1. current
2. biasing
3. plating
4. body

1-39. Klystron amplifier equipment does NOT normally have undercurrent protection in each of the electromagnetic circuits.

1. True
2. False

1-40. In a very-high-power klystron, the body current is often limited to what percent of the total beam current?

1. 8
2. 2
3. 3
4. 5

1-41. All high-powered klystrons use what type of cooling?

1. Electronic
2. Liquid
3. Gas
4. Air

1-42. What is the main source of heat in the klystron amplifier package?

1. Grid power supply
2. Beam power supply
3. Plate power supply
4. Biasing power supply

1-43. What type of noise usually occurs because the electron beam is never perfectly homogeneous?

1. Cavity
2. White
3. Grid
4. Bias

1-44. What is the primary use for traveling-wave tubes?

1. Voltage amplification
2. Current amplification
3. Power amplification
4. Bias amplification

1-45. A forward-wave TWT may be constructed to serve as what type of oscillator?

1. Stable
2. Forward
3. Internal
4. Microwave

1-46. A pulsed high-voltage power supply is called a

1. mixer
2. oscillator
3. amplifier
4. modulator

1-47. To produce a video pulse of sufficient amplitude to intensify the beam of a CRT, what voltage amplification is required?

1. l/10th
2. 3/10th
3. 5/10th
4. 10/10th

1-48. After the echo signal enters the system through the antenna, what is the next section it passes through?

1. Duplexer
2. Modulator
3. Amplifier
4. Cathode-ray tube

1-49. What is normally used to keep the receiver in tune with the transmitter?

1. Difference frequency system
2. Backward-wave oscillator
3. Frequency synthesizer
4. Local oscillator

1-50. In receivers that use crystal mixers, the power required to operate the local oscillator is

1. large
2. small
3. negative
4. positive

1-51. Reflex klystrons can also be used in RF power amplifier klystrons as

1. pulse-forming networks
2. modulators
3. drivers
4. tuners

1-52. What system is taking the place of the STALO in radar systems?

1. Local oscillator
2. Frequency synthesizer
3. Backward-wave oscillator
4. Automatic frequency control

1-53. What is the simplest type of radar mixer?

1. Magic T
2. Hybrid
3. Balanced
4. Unbalanced crystal

1-54, What is the major disadvantage of the unbalanced crystal mixer?

1. Inability to cancel LO noise
2. Inability to synthesize LO noise
3. Inability to produce LO noise
4. Inability to modulate LO noise

1-55. Which of the following factors is NOT determined by the IF section of a radar receiver?

1. Signal-to-noise ratio
2. Effective bandwidth
3. Receiver gain
4. Pulsewidth

1-56. What is used to control the gain of a radar receiver as a function of range?

1. MTI
2. STC
3. AGC
4. STALO

1-57. In what type of receivers are logarithmic IF amplifiers used?

1. F M
2. AM
3. Heterodyne
4. Electronic attack

1-58. The detector in a basic radar receiver converts which of the following signals into a video signal?

1. RF
2. IF
3. LO
4. MTI

1-59. Which of the following detectors is the simplest form of detector?

1. Diode
2. Analog
3. Logarithmic
4. Phase-sensitive

1-60. Phase-sensitive detectors are key elements in what type of radars?

1. RF
2. IF
3. LO
4. MTI

1-61. What are the basic types of pulse compression?

1. Analog and linear
2. Linear FM and analog
3. Phase coding and linear
4. Linear FM and phase coding

1-62. What type of code is the normal method used to determine phase shift?

1. Octal
2. Binary
3. Decimal
4. Hexadecimal

1-63. The extraction of the angle error is required when using what type of radar that uses phase-coded compression?

1. 2-D
2. 3-D
3. Surface
4. Tracking

1-64. What publication requires each commanding officer to establish procedures for maintaining positive control of RF transmitting equipment?

1. NAVSEA OP 3565
2. NAVSEA OP 5000
3. NAVSEA OP 5100
4. NAVSEA OP 5I00B

1-65. The emissions control bill establishes the level of EMCON during certain types of operations.

1. True
2. False

1-66. What type of program is designed to prevent the accidental activation of electro-explosive devices or electrically initiated ordnance from RF electromagnetic fields?

1. RADHAZ
2. EMCON
3. HERO
4. HERF

1-67. Which of the following programs was developed to protect fueling operations?

1. HERF
2. HERO
3. EMCON
4. RADHAZ

1-68. Which of the following programs was developed to protect personnel from RF electromagnetic radiation?

1. HERP
2. HERO
3. EMCON
4. EP

1-69. Who or what activity establishes the biological hazard levels for exposure to RF radiation?

1. Chief of Naval Operations
2. Commanding officer
3. Duty corpsman
4. Bureau of Medicine and Surgery

1-70. RF-hazard safe limits are based on what two factors?

1. Power amplification and exposure time
2. Type of equipment and environment in which it is used
3. Power density of the radiation beam and the exposure time of the human body
4. Nearness of medical personnel and type of building in which a specific equipment is used

1-71. Who has the personal responsibility for ensuring that the technician uses all safety precautions?

1. Technician
2. Safety officer
3. Safety observer
4. Commanding officer

1-72. Which of the following elements is/are used to prevent hazards?

1. Tag-outs only
2. Man-aloft chits only
3. Equipment safety devices only
4. Tag-outs, man-aloft chits, and equipment safety devices

1-73. To what publication should you refer to determine the hazards associated with specific equipment?

1. NAVSEA OP 3565, Vol I only
2. NAVSEA OP 3565, Vol II only
3. NAVSEA OP 3565, Vols I and 11
4. NAVEDTRA 12405

1-74. When working aloft on radar antennas, your man-aloft chit is designed to protect you from which of the following elements?

1. RF hazards
2. Falling
3. Weather
4. Noise

1-75. Your safety observer is responsible for your safety only.

1. True
2. False

STUDENT COMMENT SHEET

THIS FORM MAY BE USED TO SUGGEST IMPROVEMENTS, REPORT COURSE ERRORS, OR TO REQUEST HELP IF YOU HAVE DIFFICULTY COMPLETING THE COURSE.

NOTE: IF YOU HAVE NO COMMENTS, YOU DO NOT HAVE TO SUBMIT THIS FORM.

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PENSACOLA FL 32509-5237

SUBJ: *FIRE CONTROLMAN*, VOLUME 2, *FIRE-CONTROL RADAR FUNDAMENTALS*, NAVEDTRA 12404

1. The following comments are hereby submitted:

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Under authority of Title 5, USC 301, information regarding your military status is requested to assist in processing your comments and in preparing a reply. This information will not be divulged, without written authorization, to anyone other than those within DOD for official use in determining performance.

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